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STORAGE STUDY OF INDIVIDUAL SERVINGS OF SUBSISTENCE AT VARIOUS TEMPERATURES

by

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and

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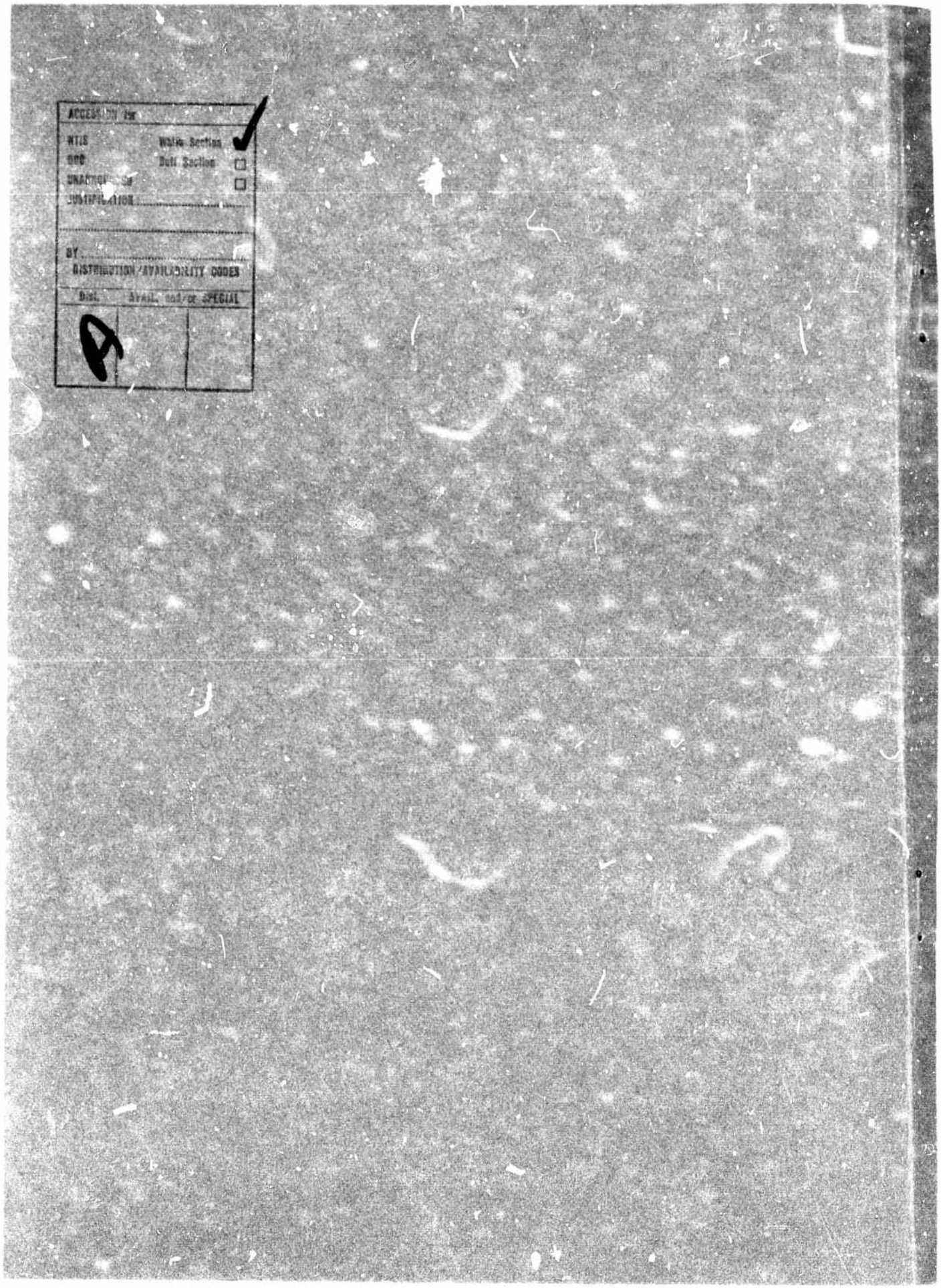
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ACCEPTANCE	MATERIALS	COLOR	ENVIRONMENTS
FOOD STORAGE	PACKAGING	WEIGHT	
FOOD	TESTS	LOW TEMPERATURE	
FOOD ACCEPTANCE	LEAKAGE (FLUID)	ADVERSE ENVIRONMENTAL CONDITIONS	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

WHILE SOME PACKAGING MATERIALS APPEAR TO OFFER MORE PROTECTION TO INDIVIDUAL SERVINGS OF SUBSISTENCE, THE RESULTS OF THIS STUDY INDICATE THAT THE DOMINANT FACTOR IN LONG-TERM ACCEPTANCE OF ANY PRODUCT IS A LOW STORAGE TEMPERATURE. IRRESPECTIVE OF THE PRODUCT AND THE METHOD OF PACKAGING, PRODUCT STORED AT 4.4°C (40°F) IS SUPERIOR TO PRODUCT STORED AT 21.1°C (70°F) WHICH, IN TURN, IS SUPERIOR TO PRODUCT STORED AT 32.2°C (90°F).

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PREFACE

Because of numerous complaints that individual servings of subsistence were received in unsatisfactory condition at the user level, a study was conducted to determine what packaging materials and what storage conditions would result in a satisfactory product.

The study was conducted by Ms. Marilee D. Witt, who has since left US Army Natick Development Center for a position in industry.

This study was undertaken under the Production Engineering Program of the Applied Technology Group, Food Packaging Division, Food Engineering Laboratory, under Project No. 728012.19.

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STORAGE STUDY OF INDIVIDUAL SERVINGS OF SUBSISTENCE AT VARIOUS TEMPERATURES

1. Introduction

This storage study was initiated because a number of Unsatisfactory Material Reports were issued on several commodities packaged as individual servings. To determine suitable packaging materials and favorable storage conditions, various servings were obtained from several suppliers. The commodities obtained - catsup, salad dressing, pickle relish, mustard, jelly, sirup, and peanut butter - are considered representative of the items covered by Federal Specification PPP-I-350, Individual Servings of Subsistence, Packaging and Packing Of, and the individual packages are representative of the types of packaging used by the industry.

One item, peanut butter, could not be tested nor could any data be collected because of the extremely high percentage of leakers in the case received from the manufacturer. The leakage was such as to cause severe oil staining of the shipping container and a film of oil over all cups in the case.

2. Test Procedures

Two principal objective approaches were used with measurements at 30- or 90-day intervals over a period of 360 days at storage temperatures of 4.4°C, 21.1°C, and 32.2°C (40°F, 70°F, and 90°F).

One approach was the determination of weight changes over the 360-day period.

The other approach was the measurement of color changes over the same period for all items except jelly, which was too dark to provide accurate color readings. Color readings were made with the Model D-1 Color Eye in terms of tristimulus values for catsup, salad dressing, mustard, and pickle relish, and the values were converted to the CIE (Commission Internationale de l' Eclairage) system for a more precise numerical description of response of the normal human eye to color. The CIE data for catsup was converted to tomato color ratings to facilitate comparison to the acceptable color rating of 72 for catsup. The intensity of the color of sirup was determined by measuring the percent of transmission of light at a wavelength of 560 millimicrons.

Determination of the acceptability of the product on criteria such as taste, texture, and package integrity was subjective and based on the judgment of the principal observer.

In addition, a survey was made of the quantity of fill to determine conformance of the specification to industry practice. Also, net weights of the samples received were determined and compared with the stated net weights.

3. Discussion

a. Net Weight Requirements

The general trend of industry fill of individual servings is shown in Table 1, and it appears that only a minimal number of changes need to be made to PPP-I-350A to bring it into line with industry practice. The fill weight figures listed in the table are those used most often by the suppliers who were contacted.

Of twenty groups of samples subjected to testing, thirteen had a net weight less than that stated by the supplier. Table 2 shows the stated net weight, actual net weight for each item, and the minimum allowable weight for individual packages. Only supplier D is consistent in giving full measure, and his controls for sirup are so loose that the fill averages almost 40 percent more than the stated net weight.

b. Weight Changes and Color Changes

In most cases, weight changes and color changes were dependent on storage temperatures with the changes being less with decreasing temperatures. In a few cases, the packaging was such that there was little to distinguish between the three temperatures at which observations were made.

(1) Catsup - Supplier A, ionomer-foil-paper pouch

Supplier B, polyethylene-foil-polyester pouch

Supplier D, polystyrene boat, polyethylene-foil-polyester lid

Supplier H, polyethylene-cellophane pouch

A study of weight changes, as shown in Table 3, indicates that storage at 4.4°C(40°F) results in less weight loss than the higher temperatures, although storage at 21.1°C (70°F) seems to give very good results. With two exceptions, weight loss increases quite rapidly at 32.2°C (90°F).

Two of the packaging materials appear to be superior to the other two. The first shown in the table, an ionomer-foil paper pouch, allowed only a small weight loss at all three temperatures. The second packaging material, a polyethylene-foil-polyester pouch, appears to be about equal to the first except that it developed pinholes which destroyed its effectiveness after 270 days. It is assumed that the ionomer in the first material is a superior barrier against the acetic acid in catsup and delays its action against the foil layer.

The effect of temperature on color changes in catsup roughly parallels the effect on weight changes (see Table 4). The general effect of time is a darkening of the product. (Note: Because of the nature of the calculation in converting from CIE ratings to tomato color ratings, a high value indicates a darkening of the product.) The one notable exception is the product in the polyethylene-cellophane pouch which undergoes a bleaching effect at 4.4°C (40°F).

There is some variation in the initial color of the catsup as received from different suppliers. Three of the suppliers have products which are essentially the same color, but supplier B's product is somewhat lighter. However, his product is near the standard color of 72 for catsup.

(2) Sirup - Supplier B, polystyrene cap, polyester lid

Supplier D, formed foil cup, foil-paper lid

Supplier H, foil cup

Supplier H, polyethylene-cellophane pouch

As with catsup, sirup weight loss is dependent on temperature (see Table 5). One packaging material from Supplier D shows a negligible weight loss at all temperatures over the entire observation period. This can be expected of a foil cup with a foil paper lid, but it is not known why the foil cup from Supplier H did not offer the same protection. The actual failure points were determined to be those times when the sirup could not be poured.

Color readings were made by transmitting light of a wavelength of 560 mμ through the sirup. There was considerable variation of the initial values between the products from the four suppliers, and the difference can be attributed to differences in the amount of the caramel color added. The percentages of light transmission shown in Table 6 tend to be somewhat confusing since some samples appear to be bleached during storage, particularly the product from Supplier D, while other samples seem to darken with increased concentration of product, such as that from Supplier H.

(3) Salad Dressing - Supplier A, polyethylene pouch

Supplier B, saran*-cellophane pouch

Supplier C, polypropylene-cellophane-foil pouch

Supplier D, polystyrene boat

Salad dressing represents the least stable in weight and color of the products included in PPP-I-350, and this is reflected in Tables 7 through 8d. Two suppliers (A and C) furnished product which was stable and acceptable at 4.4°C (40°F) and which showed relatively good stability at 21.1°C (70°F) and 32.2°C (90°F). Another supplier (E) had product which was completely unacceptable after two months at 32.2°C (90°F).

The CIE color ratings indicate a considerable difference between samples at the inception of the study. The color changes that took place can be correlated with stability, the larger changes being associated with less stable product.

(4) Mustard - Supplier C, polyethylene-cellophane pouch

Supplier G, polyethylene-cellophane pouch

Supplier H, polyethylene-cellophane pouch

The samples received from three different suppliers were packaged in the same material, a polyethylene-cellophane pouch. This particular packaging material does not offer much protection to the product as far as transmission of gases is concerned. However, the weight losses do not appear to be consistent, varying with the source of supply at various temperatures (see Table 9).

The initial color ratings of the mustard indicate that there are measurable differences between the products from different suppliers, either due to formulation, grind, or variety of seed used. The rate of color changes at different temperatures seem to bear this out. However, the results are consistent with results obtained on other products, i.e., increasing time and temperature result in a deterioration of color (see Tables 10a through 10c).

(5) Pickle Relish - Supplier B, polyethylene-cellophane pouch

Only one supplier furnished samples of pickle relish with the packaging being polyethylene-cellophane pouches. The results (see Tables 11 and 12) parallel those obtained with mustard packaged in the same material. The changes in weight and color are less at the lower temperatures.

*Saran, a product of Dow Chemical Co.

(6) Jelly - Supplier B, polyester boat, polyethylene-foil lid

Supplier C, polystyrene-PVDC boat, polyester-foil lid

Supplier D, polystyrene-PVDC boat, polyethylene-foil lid

Supplier F, polystyrene boat, polyester-foil lid

Two samples of jelly from two different suppliers in polystyrene-PVDC boats have better storage stability as indicated by weight changes than do samples in plain polystyrene or polyester boats (see Table 13). It is evident that the PVDC coating increases resistance to water vapor transmission with a resulting increase in the storage life of jelly.

4. Conclusions

While some of the packaging materials offered more protection for a given product, it appears that a low storage temperature will give the best storage life. Except for one sample of catsup, two of salad dressing, and one pickle relish sample, all twenty samples were satisfactory after 360 days storage at 4.4°C (40°F). At a storage temperature of 21.1°C (70°F), eight of twenty samples proved to be unsatisfactory at less than 360 days. At 32.2°C (90°F), eighteen of twenty samples tested were unsatisfactory at less than 360 days. It would be possible to specify packaging materials for most of the commodities based on the results obtained in this study, but the net result would be the elimination of a number of suppliers with a subsequent narrowing of the procurement base. It is our considered opinion that it would be most effective to establish a performance requirement for the various packages with a specific requirement of a low storage temperature.

TABLE 1 - Common Industry Net Weights Versus Specification Net Weights

Item	Common industry declared net weight grams (ounces)	Specification net weight - grams (ounces)
Catsup	14.17 (1/2)	14.17 (1/2)
Cramberry Sauce	14.17 (1/2)	14.17 (1/2)
Honey	14.17 (1/2)	14.17 (1/2)
Jelly	14.17 (1/2)	14.17 (1/2)
Mustard - boat, cup		9.45 (1/3)
Mustard - pouch	7.09 (1/4)	7.09 (1/4)
Pickle Relish	9.45 (1/3)	14.17 (1/2)
Salad Dressing	14.17 (1/2)	14.17 (1/2)
Peanut Butter	14.17 (1/2)	14.17 (1/2)
Sirup	42.52 (1-1/2)	42.52 (1-1/2)

TABLE 2 - As Received Net Weight Versus Declared Net Weight

Product	Supplier	As Received Net Weight, grams	Declared Net Weight, grams (oz)	Minimum Allowable Weight, grams 1/
Catsup	A	14.36	14.17 (1/2)	13.5
Salad Dressing	A	11.68	14.17 (1/2)	13.5
Catsup	B	13.28	14.17 (1/2)	13.5
Jelly	B	12.39	14.17 (1/2)	13.5
Pickle Relish	B	7.02	7.09 (1/4)	6.5
Salad Dressing	B	13.90	14.17 (1/2)	13.5
Sirup	B	42.62	42.52 (1-1/2)	40.5
Jelly	C	14.45	14.17 (1/2)	13.5
Mustard	C	6.25	7.09 (1/4)	6.5
Salad Dressing	C	8.44	8.50 (0.3)	8.0
Jelly	D	14.78	14.17 (1/2)	13.5
Catsup	D	15.65	14.17 (1/2)	13.5
Sirup	D	59.29	42.52 (1-1/2)	40.5
Salad Dressing	E	13.39	14.17 (1/2)	13.5
Jelly	F	14.00	14.17 (1/2)	13.5
Mustard	G	7.16	7.09 (1/4)	6.5
Catsup	H	12.89	14.17 (1/2)	13.5
Mustard	H	6.62	7.09 (1/4)	6.5
Sirup, cup	H	27.62	28.35 (1)	27.0
Sirup, pouch	H	41.66	42.52 (1-1/2)	40.5

1/ No individual package may be less than the minimum allowable weight. Lot average shall be not less than the specified net weight.

TABLE 3 - Weight Changes for Catsup - Thirty-day Intervals at 4.4°C, 21.1°C, and 32.2°C (40°F, 70°F and 90°F)

Packaging material and supplier	Temperature	Initial weight grams	30 days	60 days	90 days	120 days	150 days	180 days	210 days	240 days	270 days	300 days	330 days	360 days
Ionomer-foil-paper pouch	4.4°C	15.181			15.19-			**15.187**			15.185			15.161
	21.1°C	15.403			15.402			15.180			15.381			15.403
Supplier A	32.2°C	15.276	15.266	15.258	15.242	15.234	15.241	15.199	15.020		15.268	15.237		15.262
Polyethylene-foil-polyester pouch	4.4°C	14.329			**14.331**			14.329			14.339[1]			
	21.1°C	14.643			14.639			14.631			14.621[1]			
Supplier B	32.2°C	14.260	14.247	14.231	14.237	14.186	14.165	14.110		14.105	14.065[1]			
Polystyrene boat, Polyethylene-foil-polyester lid	4.4°C	16.583			16.575			16.568			16.567			16.565
	21.1°C	16.298			16.198			16.119			16.039			15.965
Supplier D	32.2°C	16.682	16.436	16.162	15.908	15.562	15.377[2]							
Polyethylene-cellophane pouch	4.4°C	14.166			14.157			14.134			14.106			14.062
	21.1°C	13.316			13.035			12.763			12.484			12.148
Supplier H	32.2°C	13.542	12.691	12.063	11.356	10.710	10.045[3]							

1/ Terminated - pinholing, delamination, light in color
2/ Terminated - weak seal, very dark
3/ Terminated - too dark for consumer acceptance

TABLE 4 - Color Changes for Catsup - Tomato Color Ratings - Thirty-day Intervals at [illegible]°C, [illegible]°C, and 32.2°C ([illegible]°F, [illegible]°F, and [illegible]°F)

Packaging material and Supplier	Temperature	Initial rating	30 days	60 days	90 days	120 days	150 days	180 days	210 days	240 days	270 days	300 days	330 days	360 days
Ionomer-foil paper pouch	4.4°C	81.01			83.47			[illegible]			[illegible]			83.23
	21.1°C	77.[illegible]			83.81			85.[illegible]			[illegible]			84.13
Supplier A	32.2°C	81.[illegible]	81.11	83.4[illegible]	85.01	85.[illegible]	87.[illegible]	[illegible].2[illegible]	[illegible].[illegible]	[illegible].[illegible]			[illegible].[illegible]	[illegible].2[illegible]
Polyethylene-foil polyester pouch	4.4°C	75.14			77.0[illegible]			[illegible].[illegible]						
	21.1°C	75.13			79.37			[illegible].[illegible]						
Supplier B	32.2°C	74.32	78.3[illegible]	[illegible].[illegible]	85.10	85.[illegible]	86.23	[illegible].[illegible]	[illegible].[illegible]	[illegible].[illegible]				
Polystyrene boat Polystyrene foil-polyester lid	4.4°C	83.6[illegible]			85.43			[illegible].[illegible]			[illegible].[illegible]			89.47
	21.1°C	85.94			90.9[illegible]			[illegible].[illegible]			[illegible].[illegible]			[illegible].[illegible]
Supplier D	32.2°C	82.17	95.[illegible]	100.[illegible]	100.[illegible]	102.[illegible]	103.[illegible]							
Polyethylene-cellophane pouch	4.4°C	82.76			71.55			[illegible].[illegible]			[illegible].[illegible]			[illegible].[illegible]
	21.1°C	81.33			[illegible].[illegible]			[illegible].[illegible]			[illegible].[illegible]			[illegible].[illegible]
Supplier H	32.2°C	84.69	90.22	[illegible].[illegible]	105.11	[illegible].[illegible]								

TABLE 5 - Weight Changes for Sirup - Thirty-day Intervals at 4.4°C, 21.1°C, and 32.2°C (40°F, 70°F, and 90°F)

Packaging material and supplier	Temperature	Initial weight grams	30 days	60 days	90 days	120 days	150 days	180 days	210 days	240 days	270 days	300 days	330 days	360 days
Polystyrene cup, Polyester lid	4.4°C	44.009			43.289						43.058			43.012
	21.1°C	44.009			42.268						39.799			38.689
Supplier B	32.2°C	44.979	42.588	40.276	38.671	36.256 1/								
Formed foil cup, Foil-paper lid	4.4°C	62.169			62.136			62.098			62.101			62.115
	21.1°C	61.794			61.748			61.740			61.758			61.738
Supplier D	32.2°C	61.858	61.837	61.839	61.832	61.829	61.823	61.823	61.820	61.818	61.618	61.819		61.842
Foil cup	4.4°C	29.709			29.631			29.754			29.508			26.706
Supplier H	21.1°C	29.442			28.754			28.124			27.460			
	32.2°C	29.524	28.281	27.162	25.930	25.617	24.243 1/							
Polyethylene-cellophane pouch	4.4°C	43.124			43.101			43.084			42.349			42.426
	21.1°C	43.074			42.765			42.526						42.062
Supplier H	32.2°C	43.047	42.355	41.711	41.256	40.387	39.694		37.736		36.796 1/			

1/ Terminated - very dry, thick

TABLE 6 - Light Transmission of Sirup at 560 mμ - Thirty-day Intervals at 4.4°C, 21.1°C, and 32.2°C (40°F, 70°F, and 90°F

Packaging material and supplier	Temperature	Initial Reading	30 days	60 days	90 days	120 days	150 days	180 days	210 days	240 days	270 days	300 days	330 days	360 days
Polystyrene cup, Polyester lid	4.4°C	61.38			61.17			59.50						61.82
	21.1°C	58.41			62.49			60.74						57.31
Supplier B	32.2°C	60.19	60.95	60.26	59.36									
Formed foil cup Foil-paper lid	4.4°C	37.92			37.98			39.16			38.94			39.28
	21.1°C	38.59			38.77			39.92			40.38			40.82
Supplier D	32.2°C	38.64	38.28	39.27	39.24	40.62	39.64	41.21	40.30	40.55	40.65	40.66	40.66	
Foil cup	4.4°C	32.66			32.92			33.00			33.59			28.60
	21.1°C	31.36			31.32			30.51			30.19			
Supplier H	32.2°C	31.63	29.31	28.70	25.41	23.49								
Polyethylene-cellophane pouch	4.4°C	24.38			24.50			24.43			25.25			24.92
	21.1°C	23.74			23.75			24.49			25.14			17.35
Supplier H	32.2°C	24.85	24.63	25.86	26.28	26.31	27.39	24.21	24.44	22.42				

TABLE 7 - Weight Changes for Salad Dressing - Thirty-day Intervals at 4.4°C, 21.1°C, and 32.2°C (40°F, 70°F, and 90°F)

Packaging material and supplier	Temperature	Initial weight grams	30 days	60 days	90 days	120 days	150 days	180 days	210 days	240 days	270 days	300 days	330 days	360 days
Polyethylene	4.4°C	12.934			12.945			12.914			12.906			12.912
Supplier A	21.1°C	12.741			12.745			12.737			12.738 2/			
	32.2°C	12.658	12.655	12.656	12.647	12.648	12.639	12.634	12.628 1/					
Saran-cellophane pouch	4.4°C	14.437			14.634			4/						
	21.1°C	14.713			14.446			4/						
Supplier B	32.2°C	15.570	14.966	14.461	14.002	3/								
Polypropylene-cellophane-foil pouch	4.4°C	9.508			9.478			9.4[illegible]			9.473			9.477
	21.1°C	9.538			9.481			9.453			9.453			9.432 5/
Supplier C	32.2°C	9.401	9.338	9.339	9.327	9.318	9.305	9.306	9.301 5/					
Polystyrene boat	4.4°C	14.709			14.599			14.518			14.438 7/			
Supplier E	21.1°C	14.219			13.124			12.336 7/						
	32.2°C	14.746	7/											

1/ Terminated - rancid, sweller
2/ Terminated - rancid, transparent
3/ Terminated - rancid, very dry
4/ Terminated - rancid, transparent
5/ Terminated - rancid, loss of cacuum
6/ Unacceptable - oily, pinholing
7/ Terminated - separated, rancid

TABLE 8a - CIE Color Ratings for Salad Dressing - X, Y, and Z Ratings at 30-day Intervals at 4.4°C, 21.1°C, and 32.2°C(40°F, 70°F, & 90°F)

Packaging material and supplier	Color Index	Temperature	Initial Rating	30 days	60 days	90 days	120 days	150 days	180 days	210 days	240 days	270 days	300 days	330 days	360 days
Polyethylene Pouch	X	4.4°C	50.72			52.83			53.56			53.89			52.32
	X	21.1°C	50.49			52.46			53.04			52.60			50.89
Supplier A	X	32.2°C	50.19	53.17	51.48	50.33	49.48	48.37	47.85	47.01					
	Y	4.4°C	64.77			55.87			56.49			56.84			56.03
	Y	21.1°C	64.44			55.85			55.96			55.44			54.30
	Y	32.2°C	64.35	62.92	54.63	53.26	52.45	51.29	50.09	49.07					
	Z	4.4°C	48.26			42.99			43.37			43.88			43.16
	Z	21.1°C	48.30			42.95			43.01			42.70			41.45
	Z	32.2°C	48.15	46.68	41.35	40.82	39.88	38.40	37.98	36.92					

TABLE 8b - CIE Color Ratings for Salad Dressing - X, Y, and Z Ratings at 30-day Intervals at 4.4°C, 21.1°C, and 32.2°C(40°F,70°F, & 90°F)

Packaging material and supplier	Color Index	Temperature	Initial Rating	30 days	60 days	90 days	120 days	150 days	180 days
Saran-cellophane pouch	X	4.4°C	66.74			58.36			58.96
	X	21.1°C	66.63			55.90			54.90
Supplier B	X	32.2°C	68.86	53.39	48.27	43.10			
	Y	4.4°C	70.98			62.25			62.32
	Y	21.1°C	70.96			59.44			57.71
	Y	32.2°C	71.09	56.76	52.05	45.15			
	Z	4.4°C	60.02			53.52			54.24
	Z	21.1°C	60.11			50.13			47.66
	Z	32.2°C	60.16	46.23	39.47	32.49			

TABLE 8c - CIE Color Ratings for Salad Dressing - X, Y, and Z Ratings at 30-day Intervals at 4.4°C, 21.1°C, and 32.2°C(40°F, 70°F, & 90°F)

Packaging material and supplier	Color Index	Temperature	Initial Rating	30 days	60 days	90 days	120 days	150 days	180 days	210 days	240 days	270 days	300 days	330 days	360 days
Propylene-cellophane-foil pouch	X	4.4°C	69.35			62.99			61.24			63.83			63.62
	X	21.1°C	71.07			62.03			62.57			61.78			62.50
Supplier C	X	32.2°C	70.82	70.05	60.60	59.99	60.28	59.38	57.94	58.55					
	Y	4.4°C	73.89			67.42			66.36			67.91			67.27
	Y	21.1°C	75.67			66.70			66.60			65.50			66.52
	Y	32.2°C	75.11	75.21	65.08	64.50	64.60	63.49	60.94	62.13					
	Z	4.4°C	61.42			57.02			57.46			57.31			56.79
	Z	21.1°C	[illegible] 5			54.84			54.35			54.80			53.69
	Z	32.2°C	.22	60.76	52.12	50.73	50.58	48.37	47.96						

TABLE 8d - CIE Color Ratings for Salad Dressing - X, Y, and Z Ratings at 30-day Intervals at 4.4°C, 21.1°C, and 32.2°C (40°F, 70°F, & 90°F)

Packaging material and supplier	Color Index	Temperature	Initial Rating	30 days	60 days	90 days	120 days	150 days	180 days	210 days	240 days	270 days	300 days	330 days	360 days
Polystyrene boat	X	4.4°C	53.61			46.34			54.68			54.53			
Supplier E	X	21.1°C	53.37			54.19									
	X	32.2°C	53.79	30.13											
	Y	4.4°C	56.68			46.47			57.13			56.94			
	Y	21.1°C	57.01			56.74									
	Y	32.2°C	56.96	31.27											
	Z	4.4°C	47.11			47.69			48.57			48.32			
	Z	21.1°C	46.34			46.93									
	Z	32.2°C	46.82	19.09											

TABLE 9 - Weight Changes for Mustard - Thirty-day Intervals at 4.4°C, 21.1°C and 32.2°C (40°F, 70°F, and 90°F)

Packaging material and supplier	Temperature	Initial Weight Grams	30 days	60 days	90 days	120 days	150 days	180 days	210 days	240 days	270 days	300 days	330 days	360 days
Polyethylene-cellophane pouch	4.4°C	6.893			6.875			6.891			6.832			6.817
	21.1°C	6.855			6.502			6.285			6.066			5.787
Supplier C	32.2°C	6.869	6.530	5.525	5.195	4.473		3.324	2.722		1/			
Polyethylene-cellophane pouch	4.4°C	8.040			7.852			7.504			7.402			7.193
	21.1°C	7.867			7.513			7.3[illegible]			7.149			6.701
Supplier G	32.2°C	7.932	7.712	7.473	7.095	6.883	6.576	6.323	6.023 1/					
Polyethylene-cellophane pouch	4.4°C	7.109			7.099			7.0[illegible]			7.069			7.044
	21.1°C	6.634			6.346			6.[illegible]37			6.289			6.159
Supplier H	32.2°C	7.604	7.265	6.920	6.718	6.248	5.920	5.666 1/						

1/ Terminated - dry

TABLE 10a CIE Color Ratings for Mustard - X, Y, and Z Ratings at 30-day Intervals at 4.4°C, 21.1°C, and 32.2°C (40°F, 70°F, and 90°F)

Packaging material and supplier	Color Index	Temperature	Initial Rating	30 days	60 days	90 days	120 days	150 days	180 days	210 days	240 days	270 days	300 days	330 days	360 days
Polyethylene cellophane pouch	X	4.4°C	39.37			36.19			36.47			36.95			36.20
	X	21.1°C	40.47			35.47			34.09			33.14			32.27
Supplier C	X	32.2°C	39.93	37.35	31.20	29.42	30.83	24.87	23.55						
	Y	4.4°C	40.24			38.29			38.16			38.71			
	Y	21.1°C	42.14			36.76			35.45			34.53			
	Y	32.2°C	41.82	39.31	32.47	30.64	28.27	25.12	23.68						
	Z	4.4°C	6.21			5.63			5.55			6.02			
	Z	21.2°C	6.13			5.28			5.05			5.01			
	Z	32.2°C	5.90	5.51	4.78	4.71	4.67	4.52	4.25						

TABLE 10b - CIE Color Ratings for Mustard - X, Y, and Z Ratings at 30-day Intervals at 4.4°C, 21.1°C, and 32.2°C (40°F, 70°F, and 90°F)

Packaging material and supplier	Color Index	Temperature	Initial Rating	30 days	60 days	90 days	120 days	150 days	180 days	210 days	240 days	270 days	300 days	330 days	360 days
Polyethylene cellophane pouch	X	4.4°C	45.23			40.5[illegible]			45.[illegible]			40.44			3[illegible].40
	Y	21.1°C	45.32			3[illegible].7[illegible]			43.[illegible]6			37.24			35.[illegible]5
Supplier G	X	32.2°C	45.3[illegible]	42.3[illegible]	36.23	35.0[illegible]	34.34	32.[illegible]	33.[illegible]5	31.20					
	Y	4.4°C	47.65			43.3[illegible]			43.4[illegible]			42.[illegible]4			41.24
	Y	21.1°C	47.79			41.09			45.[illegible]6			39.06			37.57
	Y	32.2°C	47.80	44.9[illegible]5	3[illegible].73	37.20	3[illegible].35	34.10	34.[illegible]4	32.77					
	Z	4.4°C	7.42			6.[illegible]0			7.4[illegible]			6.72			6.34
	Z	21.1°C	7.54			6.[illegible]4			7.57			6.14			6.13
	Z	32.2°C	7.67	7.27	6.59	7.02	7.3[illegible]	7.2[illegible]	[illegible].0[illegible]	[illegible].15					

TABLE 10c - CIE Color Ratings for Mustard - X, Y, and Z Patings at 30-day Intervals at 4.4°C, 21.1°C, and 32.2°C (40°F, 70°F & 90°F)

Packaging material and supplier	Color Index	Temperature	Initial Rating	30 days	60 days	90 days	120 days	150 days	180 days	210 days	240 days	270 days	300 days	330 days	360 days
Polyethylene-cellophane pouch	X	4.4°C	41.83			37.49			24.43			37.26			36.26
	X	21.1°C	41.70			36.40			35.71			35.11			33.38
Supplier H	X	32.2°C	41.98	34.03	32.11	30.33	29.60	28.19	26.98						
	Y	4.4°C	44.41			40.30			39.75			39.78			39.31
	Y	21.1°C	44.26			39.11			37.72			37.21			35.77
	Y	32.2°C	42.78	36.24	33.88	31.74	30.77	29.82	27.48						
	Z	4.4°C	7.35			6.87			6.75			6.68			6.59
	Z	21.1°C	7.43			6.92			6.74			6.82			6.59
	Z	32.2°C	7.40	6.68	7.20	7.73	7.79	7.97	7.83						

TABLE 11 - Weight Changes for Pickle Relish - Thirty-day Intervals at 4.4°C, 21.1°C and 32.2°C (40°F, 70°F and 90°F)

Packaging material and supplier	Temperature	Initial Weight, Grams	30 days	60 days	90 days	120 days	150 days	180 days	210 days	240 days	270 days	300 days	330 days	360 days
Polyethylene-cellophane pouch	4.4°C	7.752			7.724						7.676			7.354 2/
	21.1°C	7.645			7.467			1/						
Supplier B	32.2°C	7.514	7.145	6.817	5.886		1/							

1/ Terminated - excessive delamination
2/ Unacceptable - excessive delamination

TABLE 12 - CIE Color Ratings for Pickle Relish - X, Y, and Z Ratings at 30-day Intervals at 4.4°C, 21.1°C and 32.2°C (40°F, 70°F & 90°F)

Packaging material and supplier	Color Index	Temperature	Initial Rating	30 days	60 days	90 days	120 days	150 days	180 days	210 days	240 days	270 days	300 days	330 days	360 days
Polyethylene-cellophane pouch	X	4.4°C	5.810			6.300			6.151						
	X	21.1°C	5.772			6.640			6.303						
	X	32.2°C	5.034	5.503	6.383	3.670									
Supplier B	Y	4.4°C	7.116			7.460									7.473
	Y	21.1°C	6.876			7.860									
	Y	32.2°C	7.314	6.683	6.203	4.053									
	Z	4.4°C	1.992			2.087			2.077						2.220
	Z	21.1°C	1.930			2.440			2.330						
	Z	32.2°C	2.022	2.060	2.027	1.807									

TABLE 13 - Weight Changes for Jelly - Thirty-day Intervals at 4.4°C, 21.1°C, and 32.2°C (40°F, 70°F, and 90°F)

Packaging material and supplier	Temperature	Initial Weight Grams	30 days	60 days	90 days	120 days	150 days	180 days	210 days	240 days	270 days	300 days	330 days	360 days
Polyester boat, polyethylene-foil lid	4.4°C	12.898			12.877			12.878			12.866			12.867
	21.1°C	13.470			12.846			12.388			12.033 [1]			
Supplier B	32.2°C	13.339	12.394	11.695	11.220 [1]									
Polystyrene-PVDC cup, polyester-foil lid	4.4°C	15.376			15.379			15.372			15.376			15.378
	21.1°C	15.243			15.137			15.033			14.975			14.899
Supplier C	32.2°C	15.323	15.159	14.738	14.585	14.289	13.988	13.729	13.422 [2]					
Polystyrene-PVDC boat, polyethylene-foil lid	4.4°C	15.766			15.761			15.758			15.762			15.755
	21.1°C	15.579			15.504			15.454			15.414			15.375
Supplier D	32.2°C	15.742	15.495	15.331	15.094	14.889	14.589	14.522	14.309		14.012	13.694 [3]		
Polystyrene boat, polyester-foil lid	4.4°C	14.782			14.758			14.709			14.571			14.649
	21.1°C	14.962			14.009			13.513			13.019			12.505
Supplier F	32.2°C	14.535	13.281	12.303	11.449	11.182	10.910 [1]							

1/ Terminated - very dry
2/ Terminated - loss of vacuum
3/ Terminated - very dry, bad odor